Evacuated Tube Transportation Options Chart

Richard Macfarlane 26 Mar 2014
using Lucidchart

The first and most important decision is whether there is enough airflow for the air bearing skis. If the calculated airflow is too high, then wheels or maglev are the only options.

CFD Ski flow calculations

Enough airflow for air skis?

Higher cost option

No

Aiflow OK

Air Bearing Skis

Wheels

Maglev

Cooling is necessary, because the vacuum has virtually no heat transfer. So all the systems that produce heat must be cooled.

Thermodynamics calulations

Cooling using steam?

Stored steam

Ice

Would use up to 2,000 kg of ice with high freezing cost

Steam storage tank may be impossibly large

Ejected steam

Ejected steam must be pumped from tube to condensers.

Cooling

Ice

Ice cooling could be used with deep vacuum and low pod energy

Ejected steam

Ejected steam must be pumped from tube to condensers.

Cooling

Ice, little cooling needed.

Steam (water vapour) in the tube would increase the speed of sound, decrease the pod Mach No, and allow ejected steam cooling

Tube gas, air or steam (water vapour)?

Steam would be better

Tube gas air or steam?

Tube gas air or steam?

Tube gas air or steam?

A deep vacuum of 1 Pa instead of Alpha's 100 Pa would double the pumping cost, but reduce aerodynamic drag by 100 times. Ejected steam cooling needs moderate vacuum.

Air

Steam

Steam

Air

Very deep vacuum?

Very deep vacuum?

Very deep vacuum?

Very deep vacuum?

The gas flow over the pod cannot exceed Mach 1, so compression is used to get the required mass flow over or thru the pod. The use of steam reduces the pod Mach No, and reduces the compression energy.

No, 100 Pa for skis

No, 100 Pa for skis

No, about 100 Pa for ejected steam pumping

Yes, deep vacuum 1 Pa or less

Kantrowitz, Mach **0.96** in air. Compressor forces air thru duct in pod

Kantrowitz, Mach **0.76,** Compressor in pod

Kantrowitz, Mach **0.76**, Compression from wheel thrust, which increases the pressure and density in front of the pod.

Kantrowitz ignored due to very deep vacuum. Also pod is square-ended to reduce airlock pumping

Linear motors can have an active track with the power supplied to the tube. Or they can have an active rotor, with the power supplied to the pod

Traction, power needed on tube or pod?

Traction, linear motor, power needed on tube or pod?

Traction, linear motor, power needed on tube or pod?

Traction, linear motor, power needed on tube or pod?

Linear motor, power on tube

Linear motor, power on pod

Wheels, power on pod

Linear motor, power on tube

The linear motor track is high cost, so it is restricted to short sections with high acceleration. Wheels can have traction for the full length of the route.

Short lengths of 1g accel and braking

Limited accel, but available all along route

Max 0.3g accel, but traction all along route

Short lengths of 1g accel and braking

With wheels or an active rotor linear motor, the power consumption of the pod could be too high for batteries.

Batteries or pick-up power

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Batteries or pick-up power

Large batteries

Large batteries

Pick-up inside tube.

Small Batteries, low pod power

Alpha showed a flat-sided pod, but this would increase the stiffening and increase the overall pod size. All pressurised aircraft are round.

Pod - round or flat sided

Pod - round or flat sided

Pod - round or flat sided

Pod - round or flat sided

Flat-sided

Round

Round

Round

Doors on the side of the pod are more convenient, but increase the pod size and airlock power. A door at one end saves airlock pumping energy.

Passenger loading, airlock style

Passenger loading, airlock style

Passenger loading, airlock style

Passenger loading, airlock style

A pair of drive-thru airlocks requires high pumping energy, increasing total trip energy by 50%. A single in-out airlock needs less, but the pod must reverse.

Side doors on pod, 2 drive-thru airlocks. Hi pump energy

Side doors on pod, In-out airlock. Medium pump energy

End door airlock, roll-out seating module, no pump energy

Side doors on pod, In-out airlock. Medium pump energy

Just a few of the possible options

Hyperloop Alpha

Hyperloop Alpha using steam

Hyperloop Cheetah, wheels

ET3 maglev